

The Hollow Spheres of the Orgueil Meteorite: A Re-Examination

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ABSTRACT

In 1971, Rossignol-Strick and Barghoorn provided images and a description of a number of spherical hollow microstructures showing well-defined walls in acid macerated extract of the Orgueil CI carbonaceous meteorite. Other forms such as membranes and spiral shaped structures were also reported. The carbon-rich (kerogen) hollow spheres were found to be in a narrowly constrained distribution of sizes (mainly 7 to 10 microns in diameter). Electron microprobe analysis revealed that these spheres contained Carbon, possibly P, N, and K. It was established that these forms could not be attributed to pollen or other recent terrestrial contaminants. It was concluded that they most probably represented organic coatings on globules of glass, olivine or magnetite in the meteorite. However, recent studies of the Orgueil meteorite have been carried out at the NASA/Marshall Space Flight Center with the S-4000 Hitachi Field Emission Scanning

Electron Microscope (FESEM). These investigations have revealed the presence of numerous carbon encrusted spherical magnetite platelets and spherical and ovoidal bodies of elemental iron *in-situ* in freshly fractured interior surfaces of the meteorite. Their size range is also very narrowly constrained (typically ~ 6 to 12 microns) in diameter. High-resolution images reveal that these bodies are also encrusted with a thin carbonaceous sheath and are surrounded by short nanofibrils that are shown to be composed of high purity iron by EDAX elemental analysis. We present Secondary and Backscatter Electron FESEM images and associated EDAX elemental analyses and 2D X-ray maps of these forms as we re-examine the hollow spheres of Orgueil and attempt to determine if they are representatives of the same population of indigenous microstructures.

KEYWORDS: Orgueil, hollow spheres, pollen, FESEM, EDAX

BIOGRAPHICAL SKETCH

Martine Rossignol-Strick is a palynologist, paleoceanographer and paeoclimatologist, who before retirement was a Senior Research Scientist of the Centre National de la Recherche Scientifique in Universite Pierre et Marie Curie, Paris, France,. She was a Visiting Research Associate at Lamont Geological Observatory, now Earth Observatory, of Columbia University, New York, NY, for ten years. The investigation of the Orgueil meteorite took place during a six - month stay at Harvard University in the Laboratory of Professor Elso Barghoorn in the winter 1969-1970. Her other fields on interest are the paleoclimatology of the Eastern Mediterranean area during the Quaternary, as revealed by pollen analysis of cores through the deep-sea sediments of the Mediterranean Sea. She has put in parallel this climate evolution and the human protohistory in the Near East: the origin of agriculture in the 9th millenium Before Present and later the emergence of cities in southern Mesopotamia.

She also investigated in these cores the discrete layers of organic-rich marine sediments called sapropels, their origin and their conditions of formation through increased preservation of marine organic material. These recent sapropels are the modern equivalents of many petroleum source-rocks of earlier geological periods.

Richard B. Hoover is NASA/MSFC/NSSTC Astrobiology Group Leader. He holds 11 U. S. Patents and was chosen NASA Inventor of the Year in 1992. He has authored/edited 28 volumes and over 200 scientific papers/encyclopedia articles on Diatoms, Astrobiology, Microbiology, X-ray Optics and Solar Physics. His current research concerns the study of microbial extremophiles and chemical and morphological biomarkers and microfossils in terrestrial rocks and Astromaterials. He was Science Team Lead for the Antarctica 2000 Expedition to the Patriot Hills, Thiel Mountains and South Pole. He has also collected microbial extremophiles from the glaciers and permafrost of North Siberia and Patagonia as well as geysers, hot springs and volcanoes of California, Santorini, and Hawaii. He authored three new species of bacterial extremophiles from the alkaline lakes of California and one from the Pleistocene ice of Alaska. He was elevated to the rank of SPIE Fellow in 1992. He was on the Board of Directors of SPIE (1994-2002), the *Council of Scientific Society Presidents* (2002), and he was the 2001 President of SPIE.